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Analysis of the Snow Crab (Chionoecetes opilio) Fishery in Newfoundland for 1987

by

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Les Documents de recherche sont publiés dans la langue officielle utilisée par les auteurs dans le manuscrit envoyé au secrétariat.

Abstract

One population size estimation for snow crab (Chionoecetes opilio) off the east coast of Newfoundland is presented for the 1987 fishing season. Catch/effort data from sixteen crab management areas are presented along with comparative size frequency/shell conditions for northeastern Avalon, 1986-87 and Bonavista Bay 1985-87.

Résumé

On présente une estimation de la population de crabe des neiges (Chionoecetes opilio) au large de la côte est de Terre-Neuve pour la saison de pêche de 1987. On fournit aussi des données sur les prises et l'effort dans seize zones de gestion du crabe et des données comparatives sur la fréquence des tailles et l'état des carapaces pour le nord-est d'Avalon en 1986-1987 et la baie de Bonavista en 1985-1987.

105-04684/

Introduction

The Newfoundland snow crab (Chionoecetes opilio) fishery began in 1968 at Hant's Harbour, Trinity Bay. Development of this fishery proceeded at a moderate pace until the late 1970's when increased demand, processing capacity and harvesting capacity caused landings to increase yearly at a rapid pace until 1982. Since then the fishery in the Southern Zone has been in a state of collapse due to a combination of overexploitation, indicated by declining catch rates (Table 1), and a failure of recruitment mechanisms within the snow crab population.

While the snow crab fishery began to decline in the Southern Zone, the fishery in the Northern Zone began to expand. Although this expansion was rapid beginning in 1982, it proved to be brief and ended in 1985 (Table 2). At present, the Newfoundland snow crab fishery is in a state of crisis. While most stocks were declining or collapsed, a total of 97 supplementary licenses were issued in the Northern Zone in 1985. Despite a continuing decline in CPUE in this zone, the number of supplementary licenses has increased yearly reaching 175 in 1987.

An additional blow to the stability of the fishery was the dropping of the regulation prohibiting the retention of soft-shelled ("white") crabs in 1986. As most of the molting activity in the Newfoundland Region takes place during the commercial fishing season (April-December) the dropping of this regulation has resulted in fishermen landing both hard- and soft-shelled animals. This de facto mid-season recruitment into the fishery has rendered Leslie analysis useless as an assessment tool in all management areas that experienced such a mid-season pulse of molting. As this phenomenon is common throughout the Northern Zone and the deep water bays of the Southern Zone, we are once again restricted to considering comparative catch/effort and available size-frequency/shell condition data as a means of assessing the general "health" of snow crab stocks.

In 1986 Resource Management Branch imposed quotas on all management zones. These quotas were loosely based on 1985 landings, but in areas where exploitation rates were excessive, quotas were set below 1985 landing levels. While the quotas were overfished in several areas, this management initiative must be viewed as a positive step. Again in 1987, Resource Management Branch utilized quotas in order to limit fishing effort and exploitation rates. CAFSAC, following the 1986 snow crab assessment, indicated that the quota in the Northern Zone be substantially reduced. The 1987 quotas for the Northern and Southern Zones remain however, essentially the same as those for 1986.

Materials and Methods

Catch/effort data from most fishermen's logbooks were analyzed and data for each management area compared to processors' sales slips to check their veracity. From these data, biweekly catch/effort tables were constructed in order to determine whether Leslie analyses were feasible. These tables are summarized for most management areas and catch per unit effort (CPUE) plotted against cumulative catch (Fig. 2-17).

In addition to an examination of catch/effort data, several research cruises were conducted using standard crab traps fished at randomly selected locations on the commercial fishing grounds in the Southern Zone. Catches were analyzed and size frequency/shell condition histograms for various management areas (Fig. 1) were drawn. These histograms have been compared to those based on 1986 data and presented in

Figures 18 (Area 18), 19 (Area 25). A comparative summary of the performance of the crab fleet by zone is given in Table 3.

Results and Discussion

Southern Zone

The offshore areas near the southern part of the Avalon Peninsula (Areas 10 and 12, Fig. 1) continue to exhibit comparatively high catch rates which we believe are the result of a large pulse of recruitment which occurred during the fall of 1985 (Taylor and O'Keefe 1986). These areas were fished quite heavily (Table 1) during 1987 resulting in closure of the fishery in August when the quota had been reached. This early closure has presented a problem in assessing the status of the stocks with the object of forecasting the expected fishery performance for 1988. Logbook data for recent years indicates that molting activity is generally restricted to the fall. Up until the fishery was closed, fishermen had not indicated encountering any soft-shelled animals nor had we the opportunity to port-sample landings.

Leslie analysis for Area 12 was possible (Fig. 3). This exercise provides a usable biomass of 1813 t (1515-2530 t). Landings from this area (1129 t) represent an exploitation rate of 62%, slightly above the range recommended by CAFSAC.

In Area 10, fishermen were continually searching the grounds for improved catches. This activity caused CPUE's to fluctuate considerably making Leslie analysis impractical. CPUE's for both Areas 10 and 12 were roughly the same as those for the end of the 1986 fishery, 5.2 and 7.7 kg/trap haul respectively.

Catches from the Eastern Avalon (Area 14) were minimal during 1987 as effort was transferred to Areas 10 and 12.

Effort was also minimal in St. Mary's Bay (Area 8) as it was transferred to Area 10 in response to low CPUE's experienced during 1986 (Taylor and O'Keefe 1987).

The slight resurgence of the Northeast Avalon (Area 18) fishery experienced in 1986 (Taylor and O'Keefe 1987) continued in 1987 with landings and CPUE increasing by 54 t and 1.5 kg/trap haul, respectively.

Although commercial fishing vessels made exploratory voyages to the Downing Basin (Area 13) and the offshore Northeast Avalon (Area 19), catch rates were too low to be economical and the fishery was not prosecuted.

The fishery in Conception Bay (Area 16) continued to improve as landings and CPUE increased by 34 t and 3.3 kg/trap haul, respectively. Large numbers of soft-shelled crabs were encountered during a spring research cruise. It is noteworthy that most of these newly molted animals were from the deepest part ($\geq$200 m) of a trough which extends the length of the bay.

Catch rates from Trinity Bay (Areas 20 and 22) continue to be low. This bay is quite important because it is utilized by vessels from Bonavista Bay when the quota for that bay has been reached.

Catch rates in Bonavista Bay (Area 25) continue to improve from the low level reached in 1985 (Table 1). This improvement is apparently the result of the imposition of what was viewed by industry as a meager quota in 1986. Productivity in this bay has always been quite high (Taylor and O'Keefe 1984) with fishermen reporting large numbers of soft-shelled crabs each year, particularly in July and August. During 1987 there appears to have been a shift in the molting cycle. While an annual August survey found fewer soft-shell crabs than previous years (Fig. 19) port sampling conducted in June indicated a considerable proportion of the landed catch was soft-shelled (Fig. 20). The increase in CPUE of 54% over 1986 catch rates is quite encouraging however it is unfortunate that much of the 1987 landings was comprised of soft-shelled crab which produce low yield, non-premium finished product.

Northern Zone

With the exception of the Grey Islands (Area 40) the fishery in the Northern Zone was a failure for the second consecutive year. CPUE'S for all areas except Fogo Island (Area 28) decreased from 1986 levels (Table 2). Despite a high incidence of soft-shelled legal-sized crab in all areas, it is patently obvious that the resource in the Northern Zone cannot sustain present effort levels.

Despite CAFSAC advice that the 1987 Northern Zone quota be substantially reduced from that set for the 1986 fishery, the quota was not reduced.

Catch rates in this zone were so low (Table 2) that most of the full-time fleet diversified effort and prosecuted the groundfish gillnet/otter trawl and capelin fisheries for at least part of the season. As a result of both the low CPUE's and effort diversion, neither the full-time nor the supplementary fleets reached their allotted quotas of 3,000 t and 1,000 t, respectively (Table 5). Without the significant proportion of landings from Area 40 which was fished by large full-time vessels, the performance of the Northern Zone fleet would have been more abysmal; particularly in view of the fact that the low CPUE values for Areas 32, 34, 36, and 38 include soft-shell landings which two years ago were not permitted. We suggest that the only way to turn around this situation in the Northern Zone is to drastically cut the quota for the 1988 season.

Labrador

The snow crab fishery began in Labrador (Area 41) on an experimental basis in 1985. During 1985 and 1986 the fishery was predominantly prosecuted by Southern Zone vessels in order to determine the extent of the crab resource. In 1987 an attempt was made by Resource Management to transfer the crab licenses to local Labradorians who had been schooled in the "art" of crab fishing by experienced Southern Zone fishermen. For various reasons this technology transfer did not go as smoothly as all parties would have liked. As a result, fishing effort was somewhat sporadic and concentrated in more inshore areas than in the two previous years. While landings and CPUE are both lower (Table 2) than in 1985 and 1986, all parties concerned remain optimistic for the 1988 season.

3Ps

The fishery in this area is exclusively supplementary. In order to accommodate the groundfish and lobster fisheries which are the mainstay of the local economy the

snow crab fishing season is divided into spring (May 1-June 15) and fall (September 1-October 31) with a total quota of 600 t. This quota is divided (spring - 200 t, fall 400 t) in a manner determined by local fishermen's committees in consultation with officials from Resource Management Branch.

For the first time, a sufficient number of logbooks were returned and an overall picture of the fishery can be assembled.

Although the quota was caught, 596 of 600 t (Table 3), the mean CPUE was only 3 kg/trap haul. Most fishermen reported large numbers of pre-recruit and soft-shelled animals. Catch rates vary widely within Placentia Bay and while the mean CPUE was low many fishermen reported an excellent season.

Logbooks

The quality of data supplied by fishermen through their logbook returns has deteriorated markedly since 1986. Particularly alarming has been the poor quality or lack of information from full-time fishermen. Often logs are submitted with little more than the date and vessel name supplied. If the fishery is to be analyzed as thoroughly as possible, there must be improvements.

As the number of fishermen/logbooks increases through the expansion of the supplementary fishery, this exercise becomes increasingly time-consuming and, in our opinion, the results less reliable. It is hoped that a solution to this situation will be found before 1988 assessments are due.

Reproductive Capacity

Research cruises were again conducted in three areas (16, 18, and 25) during 1987. Samples of females were collected using small meshed (40 mm stretch measure) traps and examined macroscopically both internally and externally in order to determine reproductive status. Results of these examinations are summarized and presented in Table 4.

As in previous years, approximately 100% of mature females are berried. The phenomenon of primiparous females bearing eggs but not carrying spermatophores (macroscopic examination only) was again seen in 1987. Laboratory experiments monitoring egg development in these females are continuing.

Due to difficulties experienced in obtaining vessel time the yearly fall cruise in Conception Bay (Area 16) was not conducted in 1987. However, results from a spring cruise indicate that reproductive capacity remains high.

Summary

While there is evidence that the fishery remains stable in the Southern Zone and, in fact, is improving in several areas, the fishery in the Northern Zone is in a state

of collapse. It is recommended that the Northern Zone quota be drastically reduced in an attempt to stabilize the fishery and begin rebuilding the commercial stocks.

References

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1986. Analysis of the Snow Crab (Chionoecetes opilio) Fishery in Newfoundland for 1985. CAFSAC Res. Doc. 86/57. 24 p.

1987. Analysis of the Snow Crab (Chionoecetes opilio) Fishery in Newfoundland for 1986. CAFSAC Res. Doc. 87/57. 26 p.

Table 1. Summary of statistics for the Newfoundland Snow Crab fishery, 1980-87. Effort data are incomplete beginning in 1985 so mean CPUE is based on catches where effort is given in logbooks.

Area	Year	Reported effort (trap hauls)	Landings (t)	CPUE (kg/trap haul)	Estimated biomass (mt) (confidence limits)	Exploitation rate (%)
8	1980	-	-	-	-	-
	1981	11,150	168	15.0	-	-
	1982	48,350	506	10.5	551 (500-646)	92
	1983	37,780	274	7.3	341 (306-409)	80
	1984	35,400	264	7.5	-	-
	1985	23,100	164	7.1	-	-
	1986	19,570	102	4.8		
	1987	140	4	5.8	-	-
10	1983	3,080	43	13.9	-	-
	1984	18,700	175	9.4	-	-
	1985	44,890	385	8.6	-	-
	1986	91,608	930	10.2	-	-
	1987	74,890	765	10.0	-	-
12	1980	13,825	292	21.1	377 (311-728)	78
	1981	45,455	854	18.9	1291 (1114-1639)	66
	1982	49,975	732	14.7	974 (938-1017)	75
	1983	99,280	955	9.6	1045 (948-1316)	91
	1984	135,883	1068	7.9	-	-
	1985	86,937	627	7.2	-	-
	1986	116,919	1267	10.8	2133 (1752-2965)	59
	1987	85,015	1129	12.2	1813 (1515-2530)	62
13	1982	7,295	114	15.6	-	-
	1983	61,089	733	12.0	-	-
	1984	41,080	397	9.7	592 (501-790)	67
	1985	-	-	-	-	-
	1986	-	-	-	-	-
	1987	-	-	-	-	-
14	1980	5,860	121	20.6	-	-
	1981	27,113	434	16.0	614 (506-1043)	71
	1982	32,320	465	14.4	-	-
	1983	23,165	190	8.2	209 (181-260)	91
	1984	17,340	93	5.4	119 (96-275)	79
	1985	12,710	64	5.0	-	-
	1986	4,690	47	10.0	-	-
	1987	4,300	21	5.0	-	-

Table 1. (Cont'd.)

Area	Year	Reported effort (trap hauls)	Landings (t)	CPUE (kg/trap haul)	Estimated biomass (mt) (confidence limits)	Exploitation rate (%)
15	1981	18,128	404	22.3	-	-
	1982	66,949	1056	15.8	1861 (1465-3024)	56
	1983	1,320	14	10.5	-	-
	1984	-	-	-	-	-
	1985	1,140	6	5.7	-	-
	1986	-	-	-	-	-
	1987	-	-	-	-	-
16	1980	56,393	869	15.4	1571 (1214-2890)	55
	1981	43,546	502	11.2	689 (619-747)	73
	1982	60,753	694	11.4	1073 (951-1255)	65
	1983	64,175	564	8.8	-	-
	1984	52,330	333	6.4	-	-
	1985	26,060	139	5.3	-	-
	1986	32,620	193	5.9	-	-
	1987	20,265	227	9.2	-	-
18	1980	236,417	4944	20.9	14166 (9348-59867)	46
	1981	413,815	6769	16.4	11289 (910-17067)	60
	1982	153,238	1847	12.1	-	-
	1983	71,905	473	6.7	-	-
	1984	38,690	219	5.7	310 (265-402)	70
	1985	10,580	43	4.0	-	-
	1986	22,086	97	4.4	-	-
	1987	17,230	151	5.9	-	-
19	1981	65,978	1840	28.0	-	-
	1982	218,356	4194	19.2	7744 (5983-12022)	54
	1983	150,432	1662	11.0	2016 (1684-2739)	82
	1984	47,845	431	9.0	588 (504-811)	73
	1985	5,955	31	5.2	-	-
	1986	-	-	-	-	-
	1987	-	-	-	-	-

Table 1. (Cont'd.)

Area	Year	Reported effort (trap hauls)	Landings (t)	CPUE (kg/trap haul)	Estimated biomass (mt) (confidence limits)	Exploitation rate (%)
20	1980	4,550	59	12.9	-	-
	1981	14,970	110	7.4	-	-
	1982	10,535	65	6.1	-	-
	1983	12,120	72	6.0	-	-
	1984	2,180	17	6.9	-	-
	1985	4,980	19	3.8	-	-
	1986	3,420	18	5.1	-	-
	1987	6,220	44	4.9	-	-
22	1980	58,160	494	8.5	912 (788-1103)	54
	1981	24,782	178	7.2	-	-
	1982	13,755	95	6.9	-	-
	1983	20,065	107	5.3	-	-
	1984	38,240	202	5.3	260 (213-366)	78
	1985	27,560	113	4.1	-	-
	1986	30,725	165	2.9	-	-
	1987	18,040	140	3.8	-	-
25	1980	191,754	1905	9.9	-	-
	1981	171,685	1376	8.0	-	-
	1982	96,330	905	9.4	1391 (1054-2445)	65
	1983	205,353	1101	5.4	1802 (1434-2914)	61
	1984	248,962	1277	5.3	1434 (1220-1903)	93
	1985	251,720	1015	2.9	959 (909-1018)	76
	1986	127,648	648	4.6	-	-
	1987	83,222	602	7.1	-	-

Table 2. Summary of available statistics from full-time crab fishermen for the Newfoundland Snow Crab fishery (Northern Zone), 1980-87. Effort data are incomplete beghinning in 1985 therefore mean CPUE is based on catches where effort is given in logbooks.

Area	Year	Reported effort (trap hauls)	Landings (t)	CPUE (kg/trap haul)	Estimated biomass (mt) (confidence limits)	Exploitation rate (%)
28	1983	28,169	387	13.7	-	-
	1984	43,583	444	10.2	583 (498-779)	76
	1985	52,615	433	8.2	-	-
	*1986	40,997	360	4.7	640 (463-1304)	56
	1987	59,076	286	4.8	-	-
30	1983	163,138	1470	9.0	-	-
	1984	120,628	1019	8.4	2426 (1876-3765)	42
	1985	88,661	630	7.1	-	-
	*1986	34,666	535	6.0	902 (747-1236)	59
	1987	23,950	138	5.7	-	-
32	1980	33,261	374	9.9	787 (583-1229)	43
	1981	54,416	650	11.9	1845 (1193-6615)	35
	1982	130,305	1352	10.4	2213 (1605-4284)	42
	1983	88,288	537	6.1	1097 (845-1874)	49
	1984	76,491	502	6.6	1037 (821-1526)	48
	1985	81,139	476	5.9	808 (691-1022)	59
	*1986	77,412	938	3.8		
	1987	50,432	303	2.7	-	-
34	1980	7,330	96	14.3	106 (74-273)	91
	1981	19,250	322	16.7	604 (502-792)	53
	1982	51,347	735	14.3	1016 (839-7423)	68
	1983	105,756	1210	11.5	2023 (1632-3023)	60
	1984	173,038	1576	9.1	3092 (2354-5457)	51
	1985	81,655	478	5.9	757 (665-908)	63
	*1986	113,132	654	3.9	-	-
	1987	6,810	63	2.5	-	-
36	1980	17,864	158	8.8	276 (218-412)	57
	1981	19,840	230	11.6	504 (403-710)	46
	1982	32,917	418	12.7	-	-
	1983	68,497	583	8.5	1619 (1099-4692)	36
	1984	79,401	524	6.6	-	-
	1985	84,153	386	4.6	685 (533-1114)	56
	*1986	108,300	453	3.3	-	-
	1987	111,695	307	2.7	-	-

Table 2. (Cont'd.)

Area	Year	Reported effort (trap hauls)	Landings (t)	CPUE (kg/trap haul)	Estimated biomass (mt) (confidence limits)	Exploitation rate (%)
38	1983	66,123	681	10.3	-	-
	1984	102,102	948	9.3	-	-
	1985	96,796	472	4.9	719 (575-1099)	66
	*1986	49,924	246	2.7	375 (300-574)	-
	1987	20,622	48	2.3	-	-
40	1984	11,035	67	6.1	-	-
	1985	40,420	225	5.6	-	-
	*1986	95,408	772	7.1		
	1987	38,194	594	5.5	-	-
41	1985	20,419	311	15.2	-	-
	1986	39,695	467	11.8	-	-
	1987	30,060	256	8.5	-	-

(Supplementary licenced vessels are included in the 1986 landings for the northern zone.

Table 3. Summary of performance of Newfoundland Snow Crab fishery, 1980-87.

Year	Southern Zone		Northern Zone		Labrador		3Ps		Total Newfoundland	
	Catch (t)	Effort ('000 trap hauls)	Catch (t)	Effort ('000 trap hauls)	Catch (t)	Effort ('000 trap hauls)	Catch (t)	Effort ('000 trap hauls)	Catch (t)	Effort ('000 trap hauls)
1980	8190	527	628	58	-	-	-	-	8818	585
1981	12636	808	1202	94	-	-	-	-	13838	902
1982	10673	762	2505	215	-	-	-	-	13178	977
1983	6188	745	4868	520	-	-	-	-	11056	1265
1984	4476	679	5080	606	-	-	-	-	9556	1285
1985*	2605	496	3953	670	311	20	602	-	7471	1186
1986*	3467	475	3958	890	467	40	651	-	8543	1405
1987*	3083	343	2656	730	256	30	596	199	6591	1302

* Beginning in 1985, effort figures are estimated.

Table 4. Summary of reproductive status of female snow crab, Chionoecetes opilio, in three management areas in Newfoundland, 1984-87.

Area	Year	Month	# in sample	% berried females	Spermataphore type			
					% Old	% New	% Both	% None
16	1984	October	57	99	14	-	86	0
	1985	November	45	98	7	40	53	0
	1986	November	72	100	28	26	28	18
	1987	May	109	97	75	1	2	22
18	1984	May	37	100	97	-	3	0
	1985	June	55	89	42	4	55	0
	1986	June	60	98	70	7	3	20
	1987	July	53	98	56	6	34	4
25	1984	August	131	99	22	1	77	
	1985	August	106	100	8	22	70	
	1986	August	83	100	35	25	8	31
	1987	August	134	99	27	22	41	10

Table 5. Summary of Canadian Atlantic Quota Report for the Newfoundland Snow[1] Crab Fishery, December 31, 1986 compared to December 31, 1987.

Management zone	Quota allocated (t)		Reported landings (t)		Amount over/under quota (%)	
	1986	1987	1986	1987	1986	1987
Labrador	925	925	515	254	under 410 (44)	under 671 (73)
Northern Zone (full time)	3000	3000	2702	1939	under 298 (10)	under 1061 (35)
Northern Zone (suppl.)	1000	1000	1447	917	over 447 (45)	under 83 (8)
Bonavista Bay	500	500	588	602	over 88 (18)	over 102 (20)
Trinity Bay	200	100	208	253	over 8 (4)	over 153 (153)
Conception Bay	200	200	198	272	under 2 (1)	over 72 (36)
Southern Zone (excluding bays)	2400	2000	2329	2006	under 71 (3)	over 6 (-)
3Ps (suppl.)	600	600	616	562	over 16 (3)	under 38 (6)

[1] Figures presented for Bonavista Bay only are those of the authors.

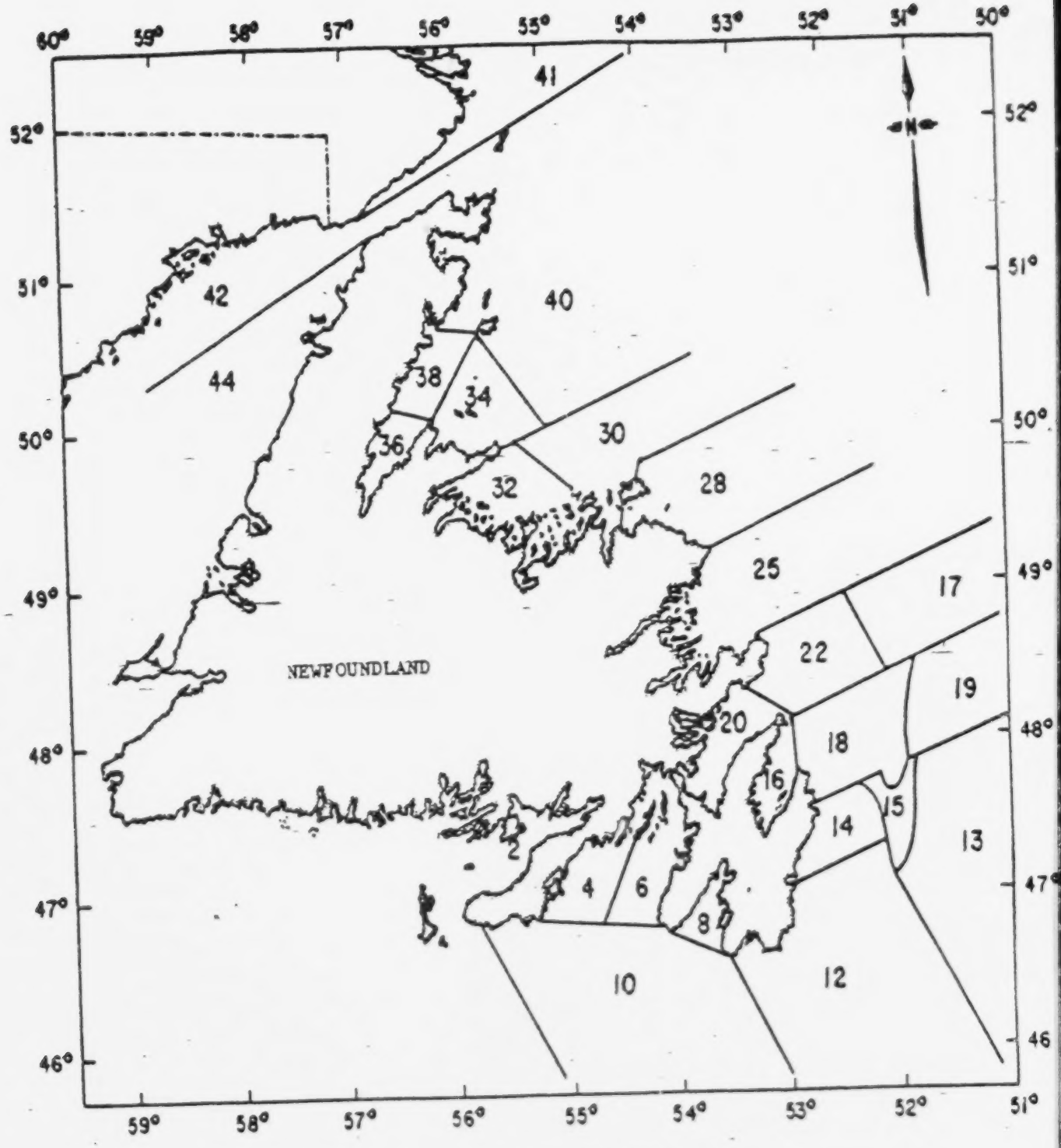


Fig. 1. Newfoundland snow crab management areas.

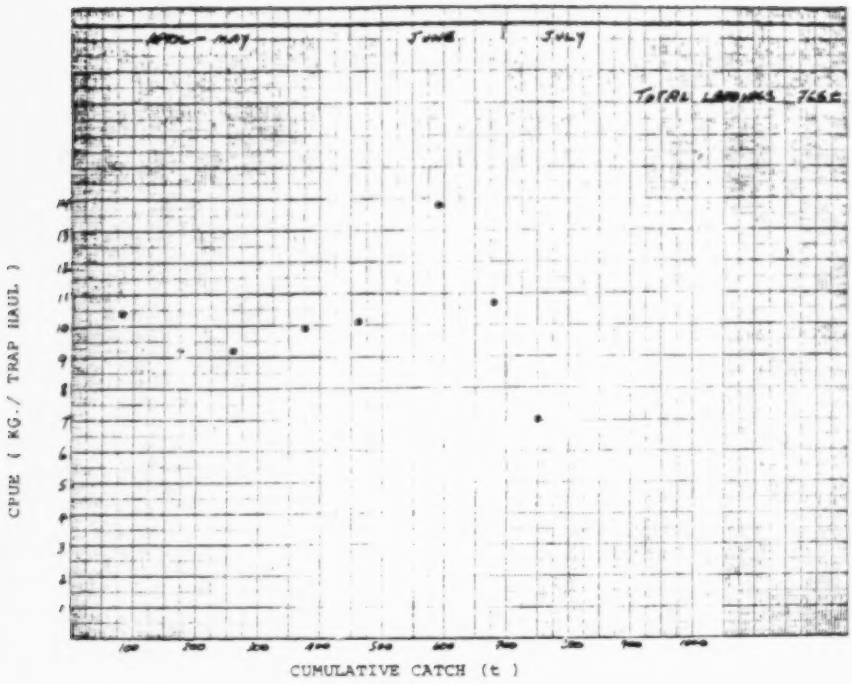


Fig. 2. Biweekly catch/effort data from Cape Race (Area 10), 1987.

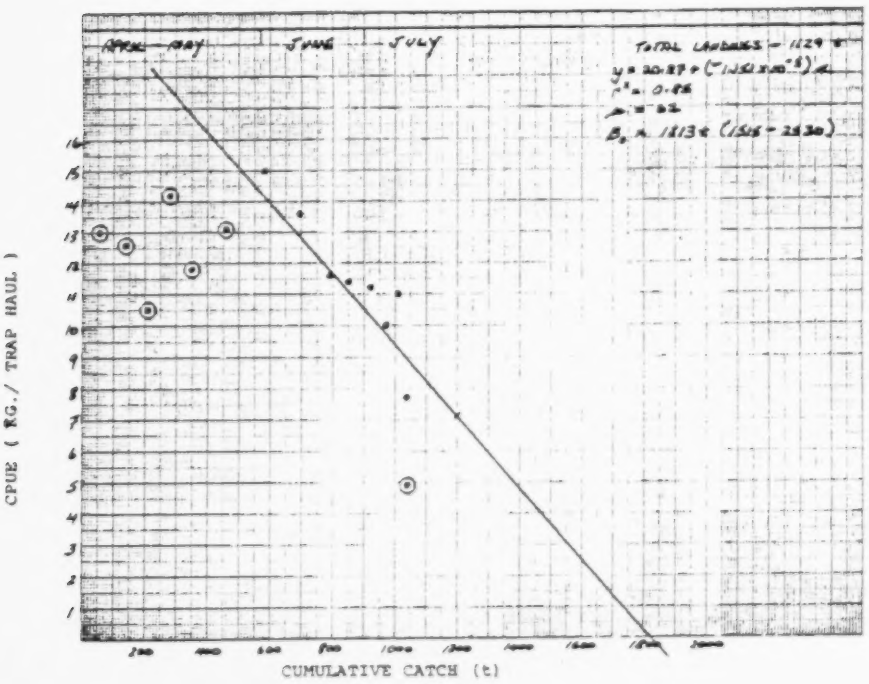


Fig. 3. Leslie graph of weekly catches of snow crab from southeastern Avalon (Area 12), 1987.

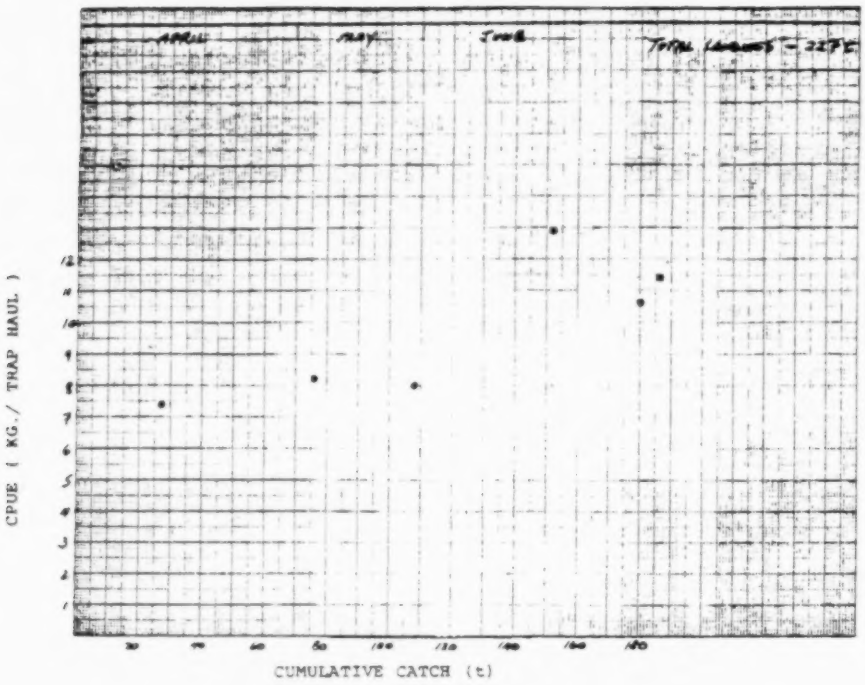


Fig. 4. Biweekly catch/effort data from Conception Bay (Area 16), 1987.

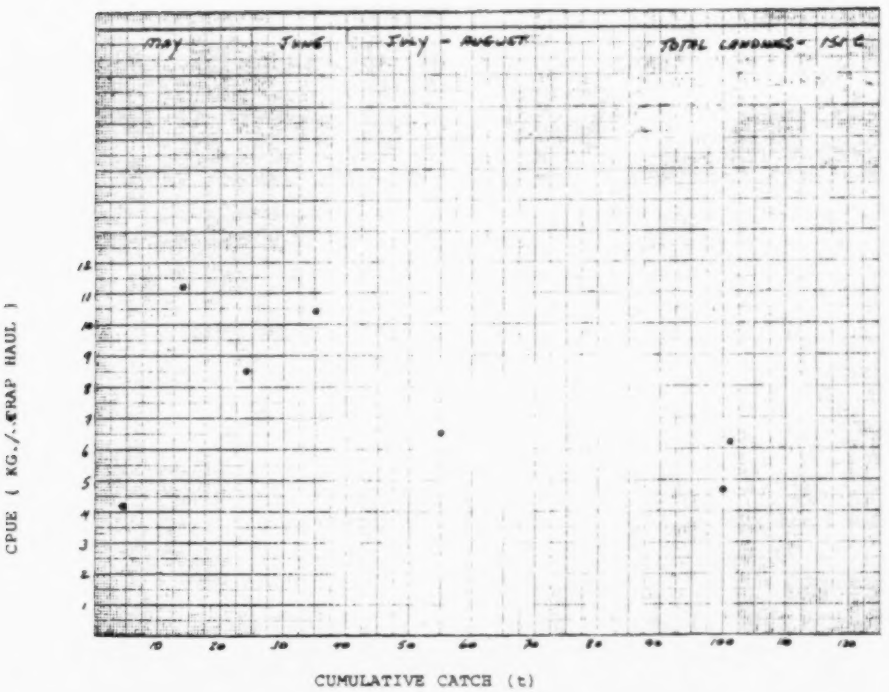


Fig. 5. Biweekly catch/effort data from northeastern Avalon (Area 18), 1987.

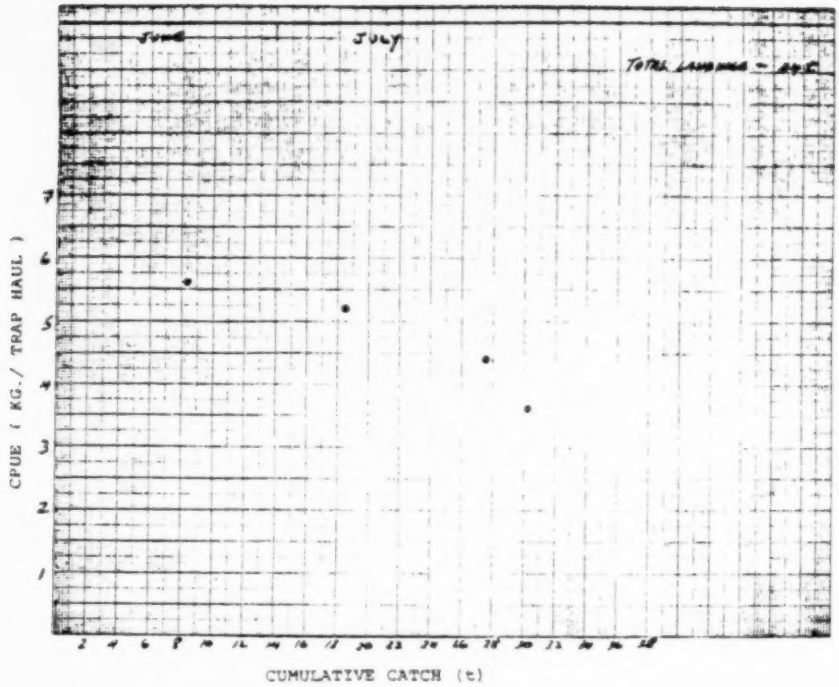


Fig. 6. Weekly catch/effort data from inner Trinity Bay (Area 20), 1987.

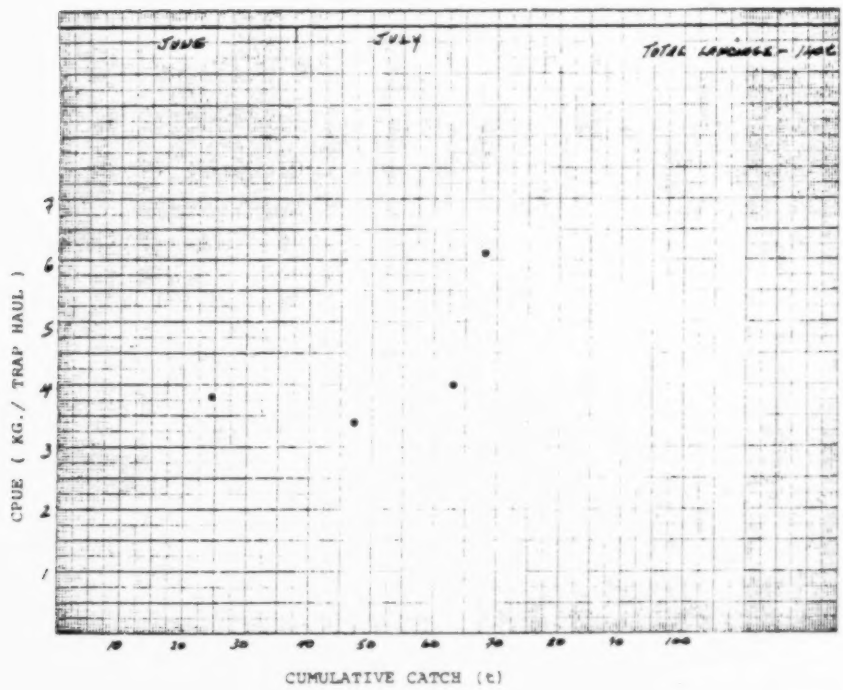


Fig. 7. Weekly catch/effort data from outer Trinity Bay (Area 22), 1987.

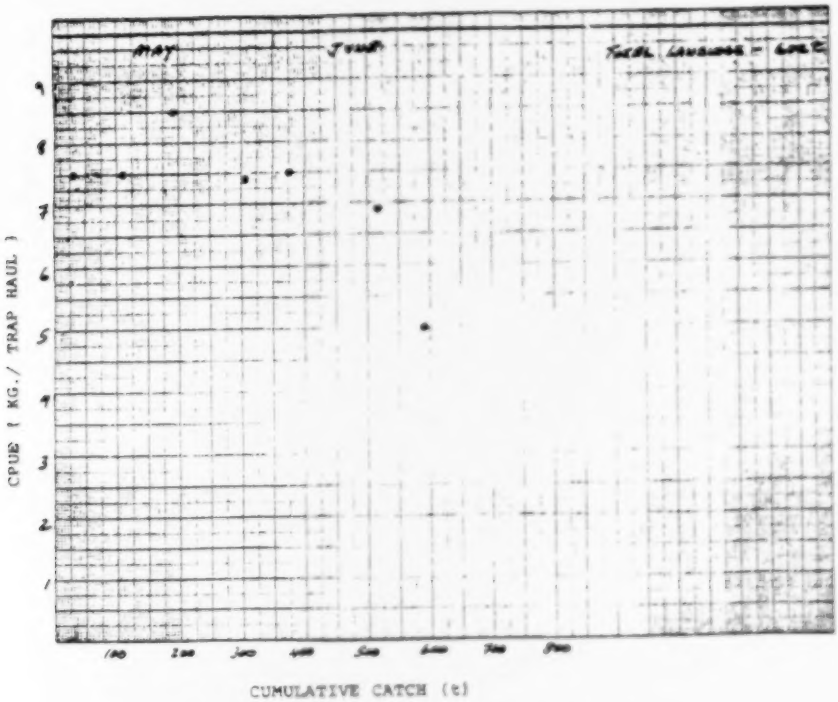


Fig. 8. Weekly catch/effort data from Bonavista Bay (Area 25), 1987.

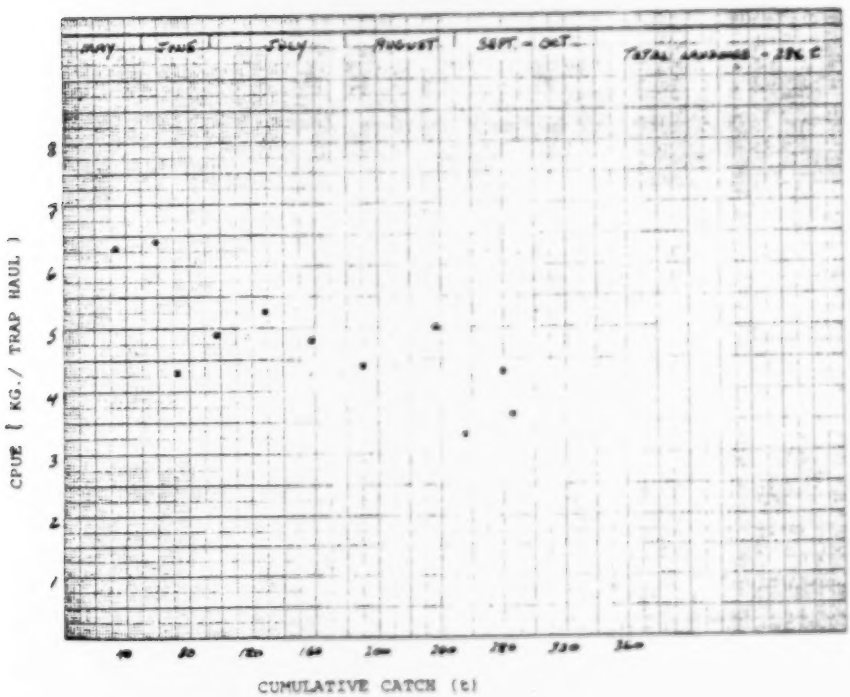


Fig. 9. Biweekly catch/effort data from Fogo (Area 28), 1987.

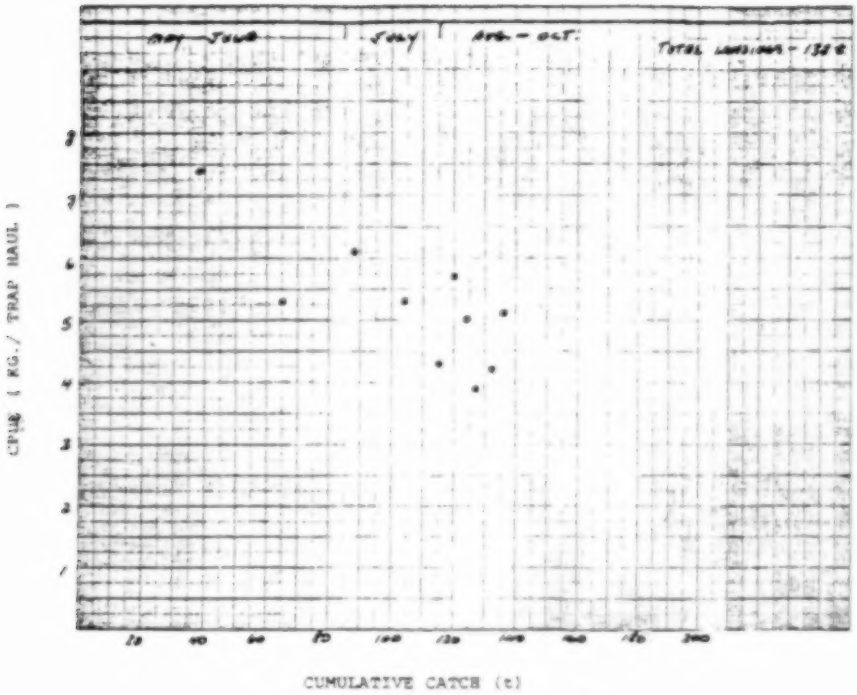


Fig. 10. Biweekly catch/effort data from Twillingate (Area 30), 1987.

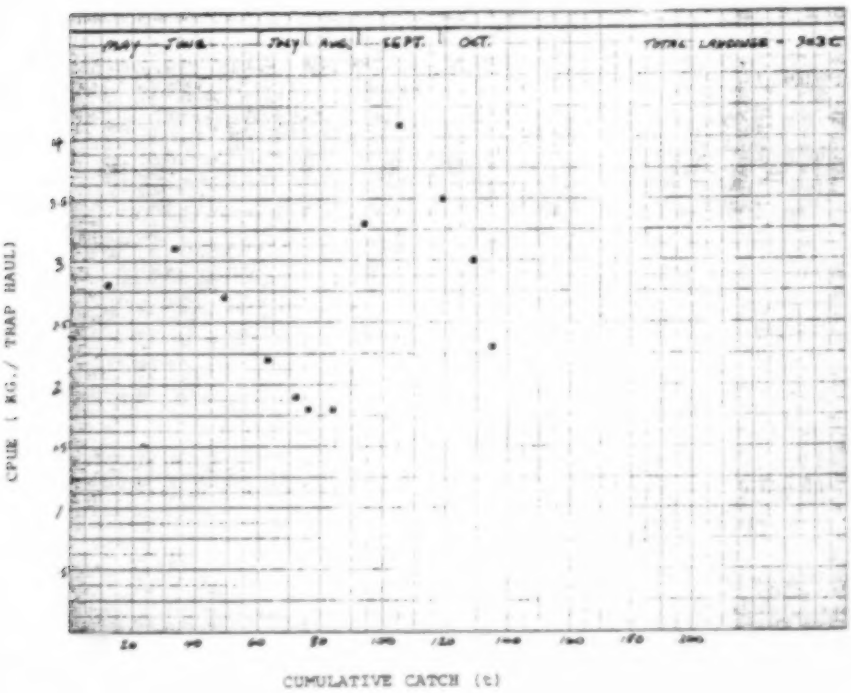


Fig. 11. Biweekly catch/effort data from Notre Dame Bay (Area 32), 1987.

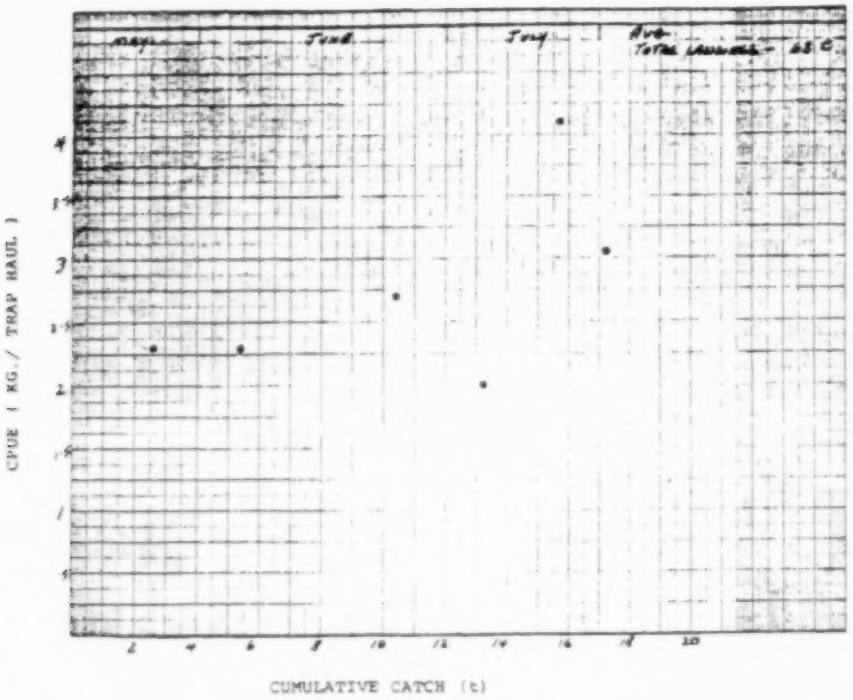


Fig. 12. Biweekly catch/effort data from Horse Islands (Area 34), 1987.

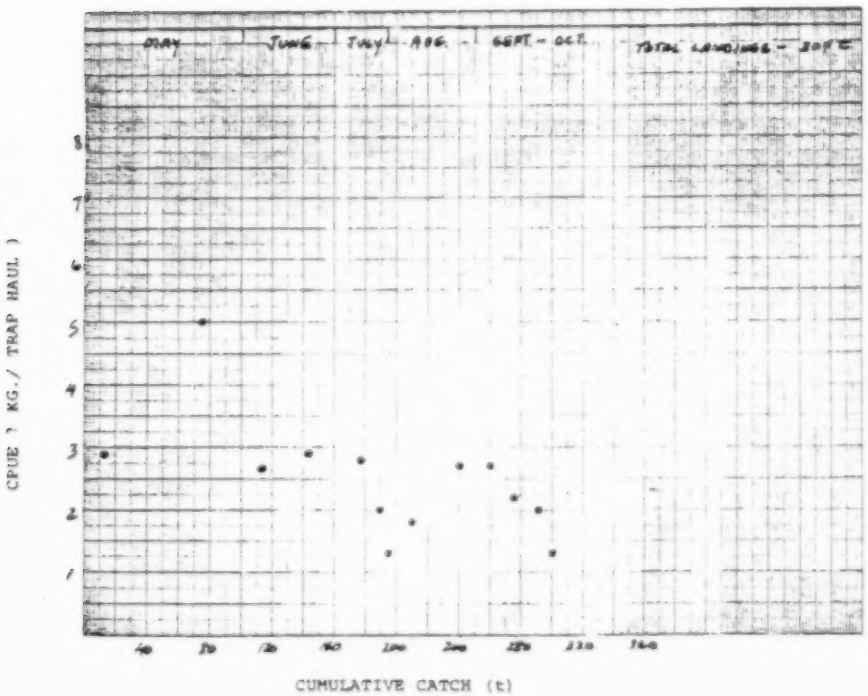


Fig. 13. Biweekly catch/effort data from White Bay (Area 36), 1987.

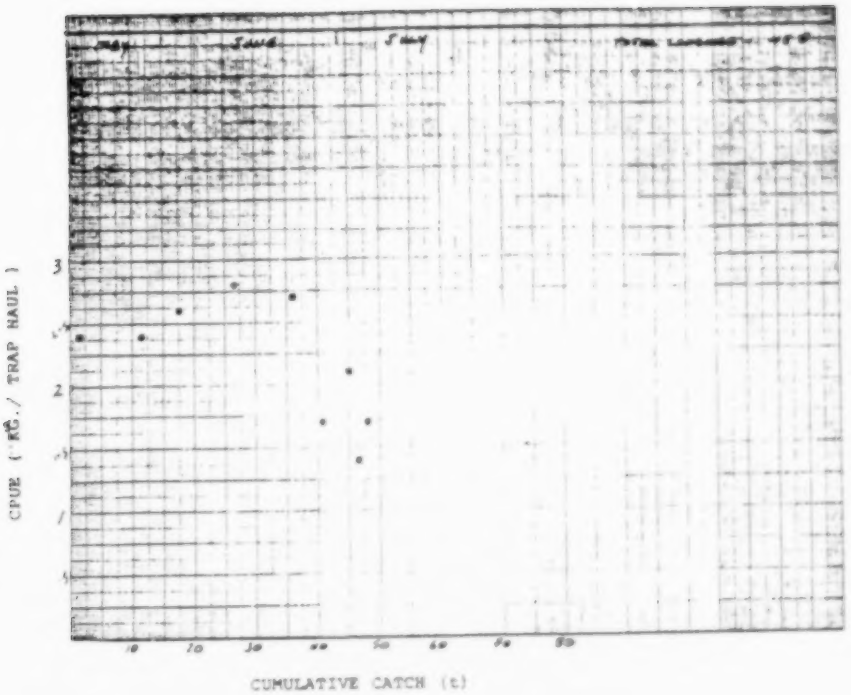


Fig. 14. Weekly catch/effort data from Canada Bay (Area 3B), 1987.

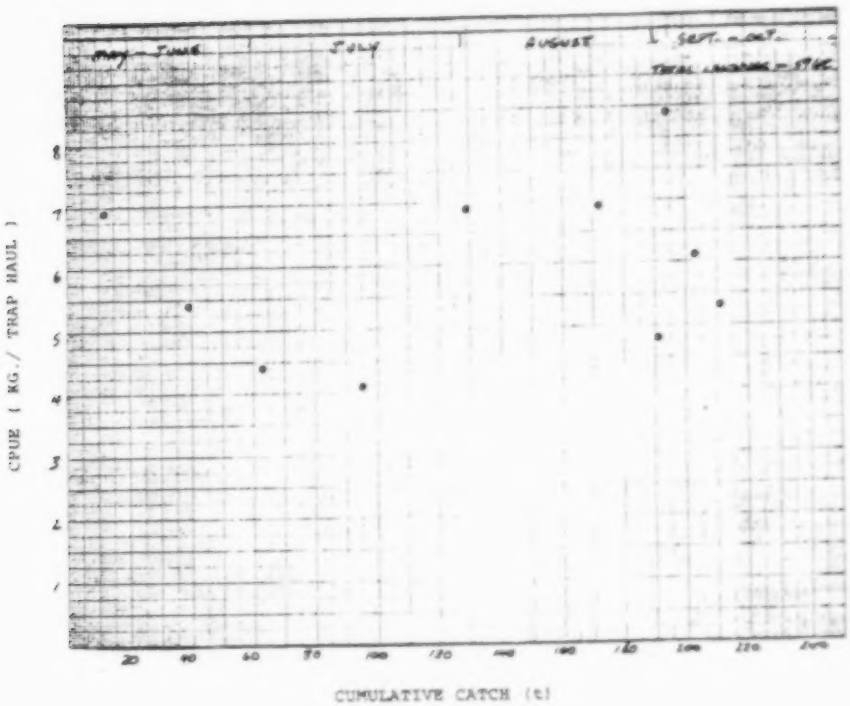


Fig. 15. Biweekly catch/effort data from Grey Islands (Area 4D), 1987.

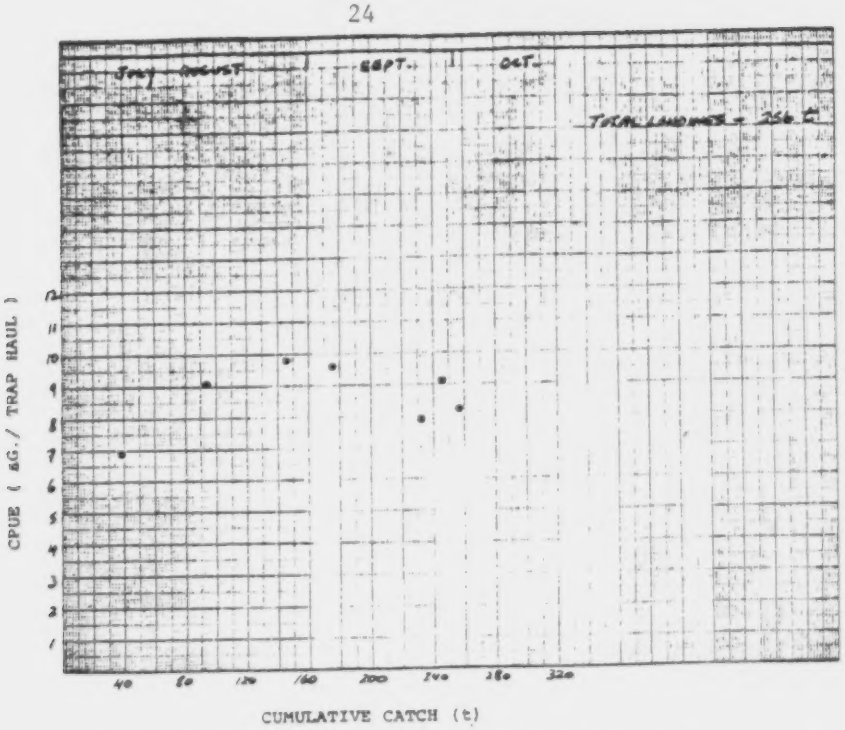


Fig. 16. Biweekly catch/effort data from Labrador (Area 4I), 1987.

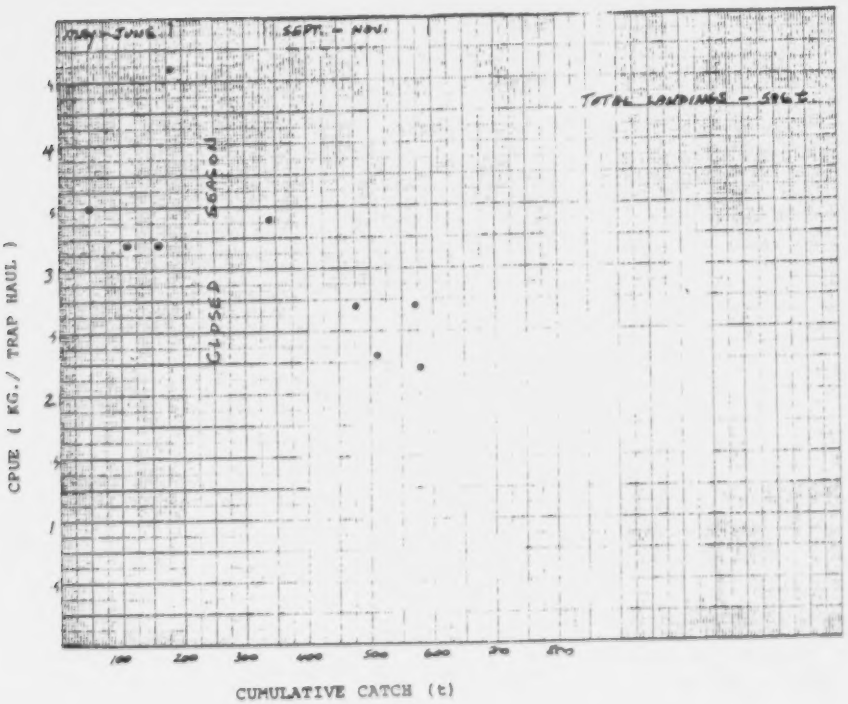
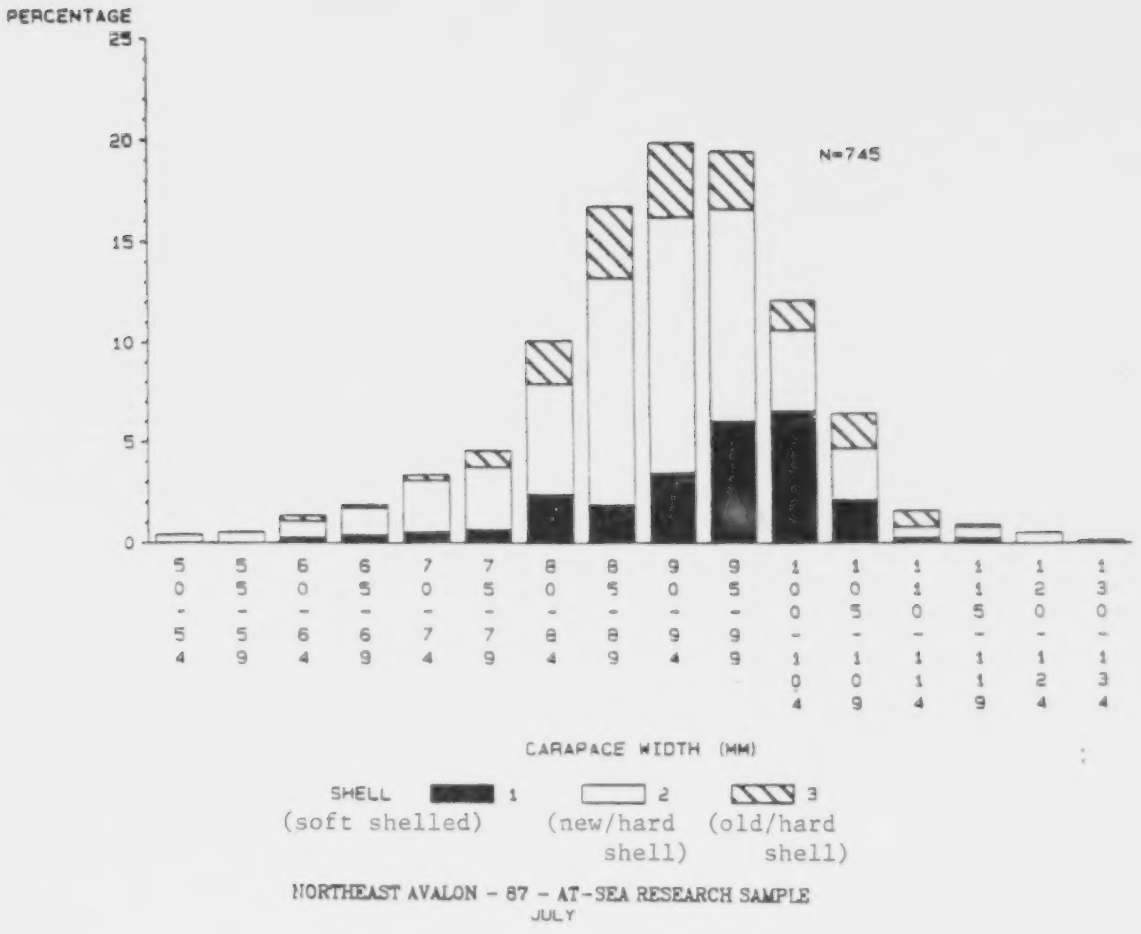


Fig. 17. Biweekly catch/effort data from Placentia Bay (Area 3Ps), 1987.



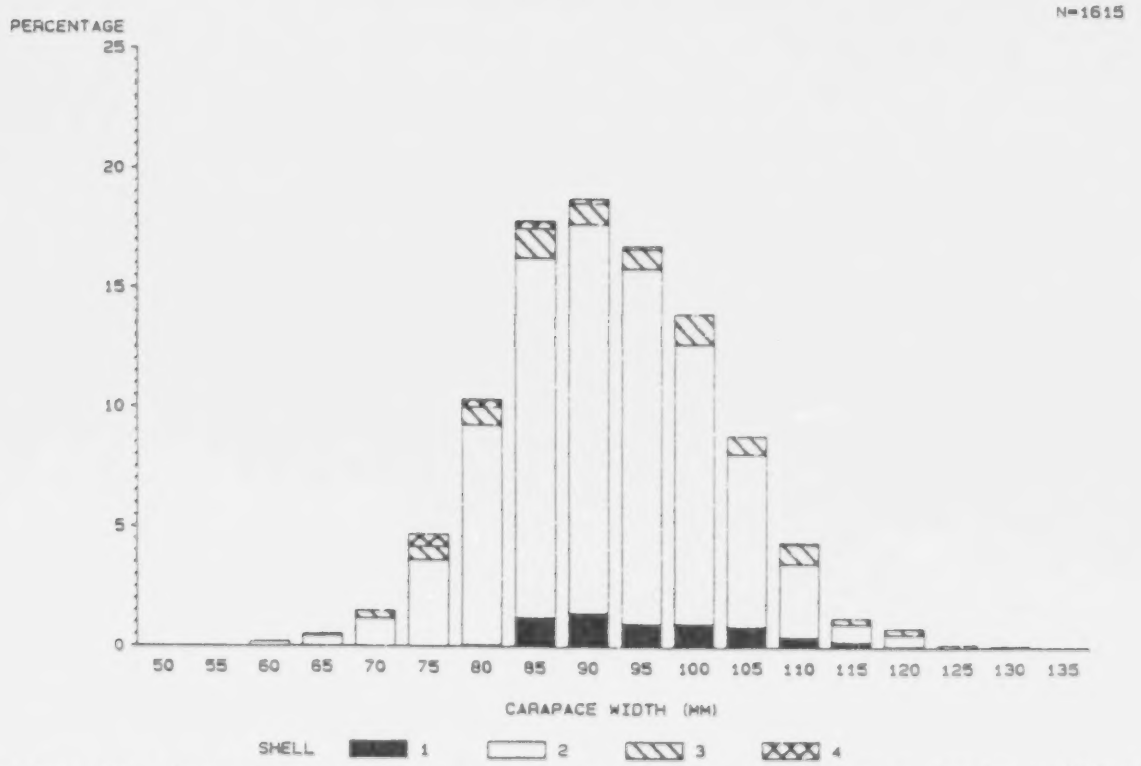


Figure 18. Snow crab size frequency distribution, northeastern Avalon, 1986-87.

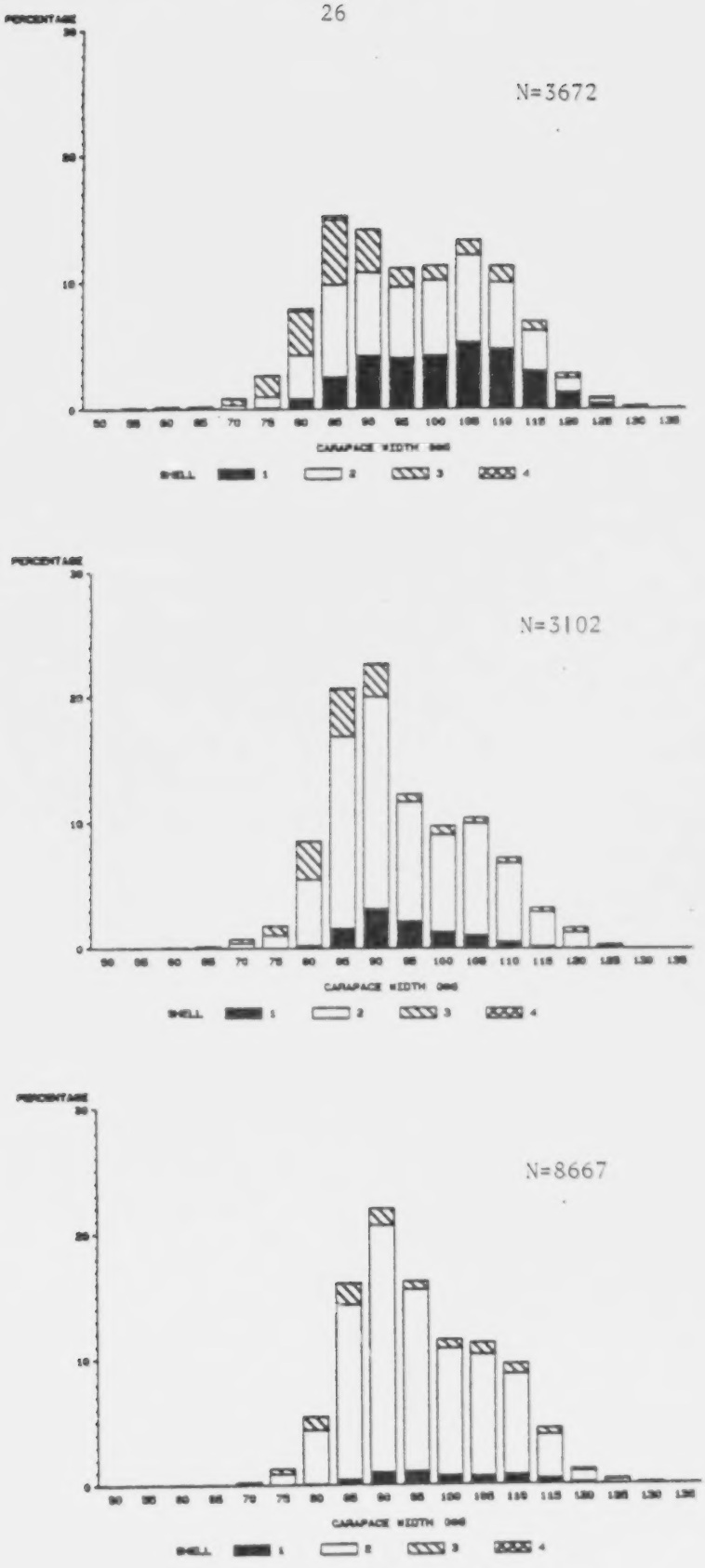


Fig. 19. Snow crab size frequency distribution, Bonavista Bay, 1985-87.

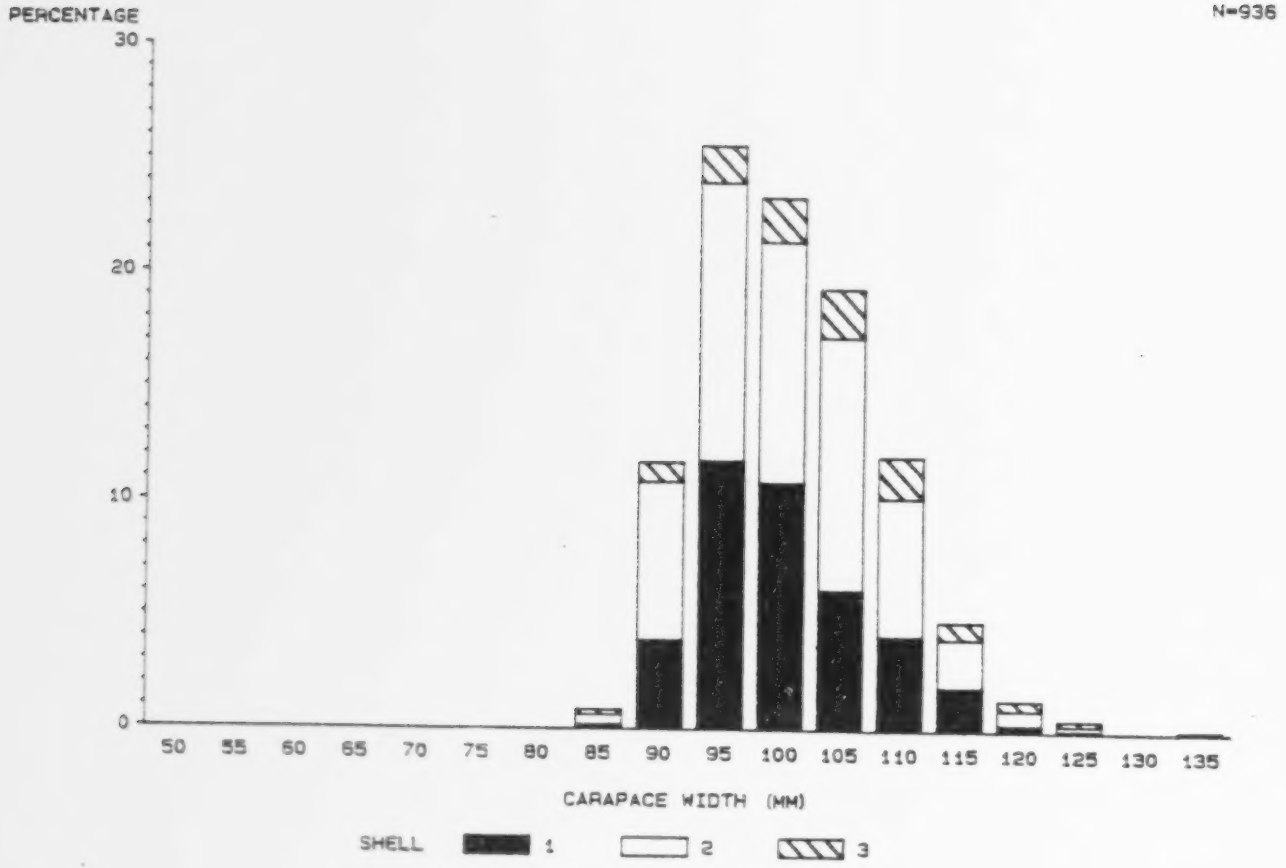


Fig. 20. Commercial plant sample, Bonavista Bay (Area 25), 1987.